ECOLOGICAL INDICATORS IN ISLAMIC BUILT ENVIRONMENT

Rashidi Othman *et al.*

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Chapter 6

URBAN WATERSHED EUTROPHICATION STATE MONITORING USING AQUATIC PLANT BASED GREEN TECHNOLOGY IN ISLAMIC BUILT ENVIRONMENT

– Nurul Azlen Hanifah and Rashidi Othman

ABSTRACT

Nature and natural resources are precious gifts to mankind. Regrettably, day by day, the world is changing bit by bit. The situations tend to be exaggerated and over exploitation of the natural resources have been rampant. One of the major crises now is eutrophication; which has become a worldwide issue. Nitrogen and phosphorus are important elements which always correlate with eutrophication. Their excessive presence in water bodies resulting from the accumulation of green algae elevates production of aquatic plants, depletion of dissolved oxygen, diminish the species diversity and affect the aquatic ecosystem as a whole. Human activities are a major contribution to this issue. Phytotechnology is another alternative new method in landscape ecology to treat eutrophication and to prove that aquatic plants can be used as indicator to evaluate and monitor state of lake ecosystem as healthy or unhealthy environment. Hence, Islam teaches that Muslims have a responsibility to protect the environment, as stewards of the Earth that God created. We are not masters who rule over the earth but servants of God with a responsibility to maintain the balance which He has created.

Keywords: Eutrophication, phytotechnology, aquatic plant, steward, protect

INTRODUCTION

The environmental crisis has been one of the most important problems in today's world. The rapid pace of industrialisation, agricultural and tourism development has brought Malaysia to be known as one of the "Asian tiger" economies. But today, despite these successful stories, Malaysia faces serious environmental problems of deforestation, pollution (*talawwuth*) of inland and marine waters, soil and coastal erosion, overfishing and coral reef destruction, along with air pollution, water pollution and the problem of waste disposal. Unfortunately, this rapid industrial development has increased the frequency of toxic pollution from the industry. There are various kinds of contaminants flowing directly into the environment; i.e. the water surface, ground water and soil before these wastages are treated. Some are accumulated, interact and settle with the living organism, plant and sediment and finally reach the coastal and ocean (Ho *et al.*, 2012).

Based on research, more than 63 percent of the rivers in Malaysia are classified as moderately to highly polluted. The Malaysian rivers receive urban runoff polluted with domestic sewage discharges and livestock excreta, as well as from agricultural uses and wastewater from factories (Sim *et al.*, 2008). They said more nutrients are the main agricultural pollutants in Malaysia. Drainage and irrigation channels, ponds and other waterways are polluted by agricultural runoff from fertiliser rich land such as vegetable farms, fruits and flower nurseries, golf courses and animal farms. Humans have exploited natural resources to a great extent until it disturbs the nature cycle itself. It started as we as human or modern man tend to forget our main responsibility as a vicegerent on earth. In addition, we have neglected nature as a sacred sign and valuable trust from Allah. Use of the world's resources should be kept in line with the nurturing and sustaining responsibilities of their roles as steward.

Imam Sadiq,

> *"There is no joy in life unless three things are available: clean fresh air, abundant pure water, and fertile land".*

Allah has called on man to appreciate the value of this so essential source of life:

> *"Have you seen the water which you drink? Was it you who sent it down from the rain cloud, or did We send it? Were it Our will, We could have made it bitter; why then do you not give thanks?"*
>
> (*Al-Waqi'ah*: 68–70)

> *"Say: Have you considered, if your water were one morning to have seeped away, who then could bring you clear-flowing water?"*
>
> (*Al-Mulk*: 30)

Interruption to natural river basins by manufacturing sectors is believed to have contributed to a major metal pollution in the environment (Hassan *et al.*, 2007; Rahman and Suriff, 1993). Rahman and Suriff, 1993 reported that major sources of wastes containing high concentrations of Cadium (Cd), Copper (Cu), Zinc (Zn), Nickel (Ni), Iron (Fe), Aluminum (Al), Manganese (Mn), Chromium (Cr) and Tin (Sn). Department of Environmental (DOE) mentioned the major pollutants detected were Biochemical Oxygen Demand (BOD), Ammoniacal Nitrogen (NH3-N) and Suspended Solids (SS).

EUTROPHICATION

Concerning the matter of water pollution, pollution is one form of corruption (*fasad*) that has been mentioned in the Glorious Quran eight times (retrieved from http://www.islam-online.net/english/...article1.shtml). Muslims, particularly, need to bear in mind that water is one of the largest trust and natural resources that Allah offers to us. Allah explains about how He creates life through water then sustains it by streams, the rains, rivers and oceans that are homes for so many creatures.

Most of the current research focuses on aquatic pollution and water quality, water resource development and management and biodiversity. Main environmental issues are highlighting eutrophication, inorganic pollution, over-exploitation, loss of biodiversity, habitat change, aquatic plant infestation and introduced species (Zati and Salmah, 2008). Eutrophication has become a global environmental problem and a major concern in the developing countries (Carpenter, 2005; Yang *et al.*, 2008). Some of water bodies in highly populated countries like China, India Bangladesh, Pakistan, Indonesia, and industrialized countries of Europe and Great Lakes states of USA and Canada are under the direct threat of eutrophication (Ansari *et al.*, 2011). According to surveys, it showed that 54 percent of lakes in Asia, 53 percent in Europe, 48 percent in North America, 41 percent in South America, and 28 percent in Africa are found in a eutrophic state (see Colin *et al.*, 2007). Carpenter, 2005 found that this issue is related to the increasing growth of human population, demand for food, land conversion, fertiliser use, and nitrogen deposition.

The Quran states that,

"... And We have made of water everything living."

(*Al-Anbiya'*, 21:30)

And,

"Water is pure and purifying."

(*Al-Furqan*: 48)

Another aspect associated with water in the Quran is the significance of water,

"And Allah has created every animal from water; of them there are some that creep on their bellies; Some that walk on two legs; And some that walk on four. Allah creates what he wills, for verily Allah has power over all things."

(*An-Nur*: 45)

In another study, Matilla and Raisanen, 1998 reported that sewage water and air pollution have also contributed to this phenomenon. Now, it is getting wider and is one of the most challenging environmental problems in the world. Water has a high top ranking in Islamic culture as it symbolises the origin and source of life. Water is the most important molecule in the life of an organism. The word water (*maa'*) is used in the Quran about 60 times and is a huge life-providing theme in the Qur'an (Shomali, 2008).

Eutrophication is defined as the state of any aquatic body in which results in an over-enrichment with plant nutrients (Seppala *et al.*, 2004; Carpenter, 2005). It can be detected as the increasing growth of phytoplanktons and macrophytes (Yang *et al.*, 2008) and accumulation of algae (Seppala *et al.*, 2004) in the water bodies. This phenomenon happens when there is an increased of excessive nutrient (phosphorus and nitrogen) which leads to high production of algae, benthos and plankton (Matilla and Raisanen, 1998; Carpenter, 2005). Yang *et al.*, 2008 draw an equation showing how eutrophication can occurs in water bodies. Based on it, water eutrophication is truly caused by algae blooming itself in water, which composes its bioplasm by sunlight energy and inorganic substances through photosynthesis. Any changes in water nutrient levels influence green biomass algae become a first tenant over the water surface. The slime layer of algae minimizing percentage

of light penetrates and depletes the dissolved oxygen of water bodies through air current (Struijs *et al.*, 2010; Ansari *et al.*, 2011; Khan and Ansari, 2005).

Due to loss total dissolved oxygen, water qualities of ponds and lakes also get affected and it leads to an early and increase level of fish decays. Fishing and navigation in eutrophic water become difficult due to enmeshed and heavy growth of plants (Khan and Ansari, 2005). As a result, the death and decay of aquatic plants produces a foul smell and makes the water more turbid (Ansari *et al.*, 2011). Bonsdorff *et al.*, 1997 mention this condition have decreased transparency, increasing amounts of oxygen-consuming drift-algal mats at shallow and intermediate bottoms, and changes in zoobenthos and fish communities. This whole process affects an ecological chain in the aquatic ecosystem itself. Hence, Allah rises up level of water in al-Qur'an several times. The water's natural cycles are described in detail in the Qur'an itself,

"(The unbelievers state) is like the depths of darkness in a vast deep ocean, overwhelmed with billow topped by billow, topped by (dark) clouds: Depths of darkness, one above another: If a man stretches out his hand, he can hardly see it! For any to whom Allah does not give light, there is no light."

(*An-Nur*: 40)

Both inland and marine waters are subject to this form of water pollution due to different sources and substances (Struijs *et al.*, 2010). In their review of this phenomenon, they agreed the present of phosphorus and nitrogen purely regulates algae growth. There is a different between inland waters and marine water which is phosphorus is most often the limiting nutrient for inland waters in temperate zones whereas nitrogen is for marine waters. In 2005, Carpenter mentions in his article that despite of excessive aquatic plant production and algae accumulation, it also decreased species diversity. He added more economic also affected because of we need to spend costs to purify the water for human use, losses of fish and wildlife production, and losses of recreational amenities. They need strive hard to grab the available sources. Increases in total production of vascular plants, changes in soil chemistry, nitrate leaching and accumulation in groundwater, and changes in plant and microbial community structure (*see* Smith *et al.*, 1999) are some of the consequences from nitrogen enrichment. In terrestrial environments, excess nutrients input resulted from human activities such agriculture and urban horticulture can elevate the potential of nutrient losses to groundwater and surface water (Gold and Sim, 2005). This lead

to eutrophication and have an effect on human as if they drink waters are too enriched in Nitrate-N or any form of products contaminated by toxic and produced through chlorination of eutrophic waters. Furthermore, they point out that soil acidification happens when there is overloading natural ecosystem (for example forest) with nutrients. Changes in the composition and diversity of native plant species are usually ecologically undesirable (Gold and Sim, 2005).

According to Finnveden and Poting (1999), any changes in nutrients balancing lead to a shift species composition. He highlights the possibility of the transportation of nutrients from one ecosystem to another one. Nutrients can still be transported to another ecosystem even though at a first place it already emitted to an ecosystem. It might therefore be that the contribution from an emission to eutrophication is always larger than zero. The main direct impact of nutrient enrichment to river system is not just has elevates algae production but it also helps to increase autotrophic production. This state has directly degraded aquatic systems (Zheng and Paul, 2008).

Eutrophication has become a serious abusive act to environment by human itself. Due to incomplete or total lack of the basic knowledge on how to preserve and maintaining water quality have gave birth to eutrophication. Islam has prohibited polluting as it contributes adverse effect to the environment. There is found one in Qur'anic verse mentioning and obliges the whole society to avoid polluting the environment and it is applicable to any type of pollutions happening nowadays.

> *"Do no mischief on the earth, after it hath been set in order, but call on Him with fear and longing (in your hearts): for the Mercy of Allah is (always) near to those who do good."*
>
> (*Al-'Araf*: 56)

Prophet Muhammad (PBUH) said, "*There should be neither harm, nor reciprocating injury.*" Also, Prophet Muhammad (PBUH) warned against urinating or defecating in people's pathways, in water and in the shade of trees as all these things are of great benefit to people.

ECOLOGICAL INDICATOR

Allah has created everything in this world for reasons. Each of His creations personally functions and contributes to the environment as well as to mankind.

He has created everything in this universe perfectly and meant to as where it is. He has highlighted in Qur'an,

> *"Verily, all things have We created in propotion and measure."*
>
> (*Al-Qamar*: 49)

> *"... Everything to Him is measured."*
>
> (*Al-Ra'd*: 8)

And

> *"And We have produced therein everything in balance."*
>
> (*Ar-Rahman*: 7)

Concept of *Kashif* (pollution) *Al-Talawwith* (indicator) is one of the initiatives in Islamic approaches in achieving environmental balance. Human could use *tallawwith* as a guideline to access and monitor the state of environment as time to time. They can provide an early warning signal of changes in the environment. Therefore, anything surrounds us can be used to benefit us. In our environment, there are indicators live within it. It has all been created for the benefit of humankind and human may use what he desires to his heart's content.

Ecological indicators are simple measures in comparison to the complexity of ecosystems. We use environmental indicator to mean metrics derived from observation (i.e., data) that are used to identify indirect drivers of environmental problems (for example, population or consumption growth), direct pressures on the environment (for example, overfishing), environmental conditions (for example, air pollution concentrations), broader impacts of environmental conditions (for example, health outcomes), or effectiveness of policy responses (OECD 1991). Indicators provide information on the state of the environment, and changes in their levels over time can serve as early-warning tools and help to diagnose the causes of environmental problems (*see* Dale and Beyale, 2001). They may also help to predict future states of ecosystems and to identify actions for mitigating undesirable changes (Niemi and McDonald, 2004). In a talk session with ScienceWatch.com, Niemi and McDonald (2008) had explained how well and important the ecological indicator impacts are to the ecosystem. Ecological indicator could give more

precise and direct measure of ecosystem condition than the more traditional chemical measures. Furthermore, they mentioned if ecological indicators are using in a direct manner, they could give a sign to us telling the quality of the environment itself. This is a unique function of ecological indicator.

Aquatic Plants as Ecological Indicators

Every living being adds value to its ecological system. Aquatic plants are important components in freshwater ecosystems. They (or aquatic macrophyres) live in wet habitats. "True" aquatics, or hydrophytes, turn out in permanently wet places, but others known as helophytes are more amphibious and may put up with seasonal drying. The distribution and abundance of aquatic plants are influenced by variations of environmental factors. This fact can be used to identify species and communities that are reliable indicators of important changes in their ecosystem (Freedman and Lacoul, 2006). They mentioned further that the value of indicators is related to their sensitivity to both longer and shorter term changes in environmental factors. Melzer (1999) also pointed out in his research that aquatic macrophytes subjected as integrators of environmental conditions thus can be used as long term indicators with spatial resolution. Aquatic plants can be successfully used for these useful purposes, alone or in association with the monitoring of other kinds of organisms.

Plants and animals are connected to each other as both of them benefitted each other. They act as living resources of million benefits. Allah SWT has not made something worthless and meaningless, each of them are unique and irreplaceable. Once we lose it, it will be gone forever. By virtue of their unique function of producing food from the energy of the sun, plants constitute the basic source of sustenance for animal and human life on earth. Allah SWT has said,

> *"Then let man consider his nourishment: that We pour down the rain in showers, and We split the earth in fragments, and therein make the grain to grow, and vines and herbs, and olives and palms, and gardens of dense foliage, and fruits and fodder - provision for you and your cattle."*
>
> (*'Abasa*: 24–32)

In conjunction with that, aquatic ecosystems are responsible for a wide variety of functions valuable to human society. They have various advantages to the

environment such as they convert wastes to become less harmful, sometimes useful, materials; recycle nutrients; recharge groundwater aquifers; serve as habitat for wildlife; are a valuable recreational and aesthetic resource; soothe floods and boost and maintain stream flow (Cairns, 2006). Aquatic plants are important components of many freshwater ecosystems. This species vary greatly in their anatomy, physiology, life-history traits, and ability to tolerate inorganic and biological stressors. Most of aquatic plants live in freshwater such as in lakes, ponds, reservoirs, canals or rivers and streams. These habitats are very different in water depth, flow rates, temperature, acidity and alkalinity (pH) and mineral content. Some aquatic plants live in river mouths with an ever-changing mixture of freshwater and saltwater and also a few live completely submerged in the sea (Horton, 2001) and abundance of aquatic species which are water movement, substrate, light, temperature (water) and water depth. The aquatic plants have several similar habitat requirements regardless of life form. According phytoremediation is the direct use of green plants and their associated microorganisms to stabilize or reduce contamination in soils, sludge, sediments, surface water or ground water. Sites with low concentration of contaminations with large clean up areas and at shallow depths present especially favourable conditions for phytoremediation (U.S. Environmental Protection Agency 2011).

In the Quran, it is repeatedly mentioned that every action, either good deeds or bad deeds, will be questioned and judged upon on the Day of Judgement (*akhirah*) including on how we have treated the environment and animals.

> *"So whoever does an atom's weight of good will see it, And whoever does an atom's weight of evil will see it."*
>
> (*Al-Zalzalah*: 7–8)

Being a steward (khalifah) means having authority over creation, but a steward is also accountable over his/her treatment of the environment. Anyway somehow, we have altered the perfect balance created by Him.

> *"Verily, all things have We created in proportion and measure"*
>
> (*Al-Qamar*: 49)

Furthermore, He even tells human beings not to disturb this balance.

"And the sky has He raised high, and has devised (for all things) a balance, so that you might never transgress the balance: weigh, therefore (your deeds) with equity, and do not upset the balance"

(*Ar-Rahman*: 7–9)

Therefore, phytoremediation is one of the green-based technology approaches to encounter back the destruction made by humans. The main aim (*maqasid*) behind the development of phytoremediation technologies is their eco-friendly and cost-effective nature. Phytoremediation offers a cost-effective, nonintrusive, and safe alternative to conventional clean-up techniques. Contaminant removal from contaminated soil, sediments and water can be done by using the existing tree, shrub, and grass species (Kamal *et al.*, 2003). Moreover, it is more ecological and efficient when dealing with the rise of global heavy metal contamination.

Chorom *et al.*, 2012 believe that this emerging technology has an enormous potential to treat wide range of contaminants besides its cost-effectiveness, long-term applicability and ecological aspect. This technology is based on the ability of plants to absorb and accumulate metal contaminants in their tissues and eliminate high amount of these elements from water or groundwater. The process of phytoaccumulation requires metal absorption by roots and its translocation to shoots and leaves. They mentioned that the bioremoval process using aquatic plants contains two uptake processes biosorption which is an initial fast, reversible, metal-binding process and bioaccumulation, a slow, irreversible, ion-sequestration step (*see* Keskinkan *et al.*, 2003). Phytotechnology has many remediation mechanisms which are phytoextraction, phytostabilisation, phytovolatilisation and phytofiltration whereby plants are used to clean up sites by removing pollutants from soil, sediment, water and air (Padmavathiamma and Li, 2007). However, the effectiveness and economic viability of a phytotechnology method depend on the climate, elevation, precipitation, soil type and quality, the type, age, distribution and concentration of contamination, media and the viability of the plants and planting system used for each site.

CONCLUSION

"And do no mischief on the earth, after it has been set in order, but call on Him with fear and longing (in your hearts): For the Mercy of Allah is (always) near to those who do good."

(*Al-A'raf*: 56)

Surely, our present world has witnessed the most dreadful kind of corruption on earth and environmental, as well as, natural destruction which man was enjoined to protect and take care of. Thus, in short, as God has created this world and entrusted it to human beings alone, they are not the owners and masters of the natural environment. They are only trustees, stewardships on earth. Allah SWT has created the whole universe with perfect wisdom (*hikmah*) and everything is in perfect orders. Each factors, number, quantity and quality are precisely determined by the divine plan. Indeed those nothings in this world are permanent, but that does not give us a license to alter our surroundings. Man's disruption to the natural balance leads to various problems that are reflected on him as well as other creatures on earth. In the Qur'an it was mentioned,

"We created not the heavens and the earth and all between them but for just ends, and for a term appointed: but those who reject Faith turn away from that whereof they are warned."

(*Al-'Ahqaf*: 3)

Hence, the concept of *Khasif al-Talawith* suits well as it would be, in the future, a guideline in controlling, preserving and protecting our environment. Islamic environmental ethics covers areas of waste minimisation, water conservation, animal rights and sustainable land management. Together we as trustee of Allah SWT must preserve and protect our world in line with His guidance.

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ECOLOGICAL INDICATORS IN ISLAMIC BUILT ENVIRONMENT

In this growing fast modern world, environment has taken up the most from the growing world. People seems to forget that earth is a responsible God gives to humanity to develop a hence make it a greater place for human being. As stated in Holy Quran, Allah bestowed humanity as *Khalifah*, so humanity has to obey it and make use of the environment and not destroyed it. Sadly, environmental degradation has occurred due to fast growing human activity. Thus, humankind has to be intelligence and use the environment itself as the solution to this problem.

Remediation technologies such as ecological indicator have shown promising sign to be a possible solution to this problem. Plants can play a major part in balancing the quality of the environment with the modern world as well as help maintaining the biological diversity through biological indicator, a method of using plants as an indicator to assess environment conditions.

Human interference with nature is happening constantly than ever now but it can be a win-win situation for both. Human need to take a closer look in nature friendly solution and develop some ways to incorporate nature as the solution, thus open up, and use the best solution that God gives us that is nature.

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